21 September, 2015

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ATTN: Aquifer Exemption

Submitted electronically via Comments@conservation.ca.gov

On behalf of the Natural Resources Defense Council ("NRDC"), which has 2.4 million members and activists, more than 380,000 of whom are Californians, we write to submit our comments on the proposal to expand the current aquifer exemption designation for the Dollie Sands of the Pismo Formation in the Arroyo Grande Oil Field located in unincorporated San Luis Obispo County, near the intersection of Ormonde Road and Price Canyon Road.

At the outset, we must state our strong objection to the inadequate and outdated criteria[1] that are used when deciding whether to grant aquifer exemptions like the one at issue here. When the U.S. Environmental Protection Agency ("EPA") was crafting its underground injection control ("UIC") program regulations in the early 1980s, the agency bowed to pressure from the oil industry and watered down the aquifer exemption criteria in response to a lawsuit brought by the American Petroleum Institute.[2] The oil industry's influence on the exemption criteria was not rooted in science or groundwater needs, but rather was based on industry's fears that robust aquifer exemption criteria might prohibit the use of certain technologies.[3] Moreover, the weak exemption criteria were based on treatment technology that was available at the time, *i.e.* more than thirty years ago. EPA has not updated the criteria since then, and in the meantime, treatment technologies have improved considerably and in fact are in great demand today due to chronic drought conditions that are driving water users in some parts of the country to turn to lower-quality water sources. To put it bluntly, the exemption criteria are outdated and wholly inadequate to protect usable groundwater.

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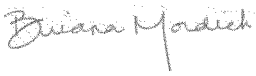
[1] 40 C.F.R. § 146.4(a)-(c).
[2] Noel, John. *Aquifer Exemptions: A First-ever Look at the Regulatory Program That Writes off Drinking Water Resources for Oil, Gas and Uranium Profits.* Rep. Clean Water Action/Clean Water Fund, Jan. 2015. Web. 10 Apr. 2015.
[3] Taylor, K. A., Fram, M. S., Landon, M. K., Kulongoski, J. T., & Faunt, C. C. (2014). *Oil, Gas, and Groundwater Quality in California - a discussion of issues relevant to monitoring the effects of well stimulation at regional scales.* Sacramento: U.S. Geological Survey California Water Science Center.

As our more detailed comments below will demonstrate, the proposed aquifer exemption at issue here fails to meet even EPA's deficient exemption criteria, much less the more stringent "beneficial use" requirements set forth in the California's Public Resources Code. For these reasons, we urge the Division and the Water Boards to reject this aquifer exemption application and refrain from sending it on to EPA for approval.

Respectfully submitted,

Lance Larson
Science Fellow



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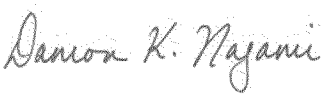

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INTRODUCTION

California's Groundwater Crisis

California's drought, now in its fourth year, is causing terrible hardship and impacts across the state to rural communities, agricultural users, and fish and wildlife populations. The state's Department of Water Resources has announced that "[b]ecause of increased pumping, groundwater levels are reaching record lows—up to 100 feet lower than previous records"[4], which in turn is exacerbating the already alarming subsidence rates in the Central Valley.[5]

In the midst of this historic drought, it was revealed that more than 2,500 wells have been improperly permitted to inject potentially toxic oil and gas wastewater and other fluids into federally protected Underground Sources of Drinking Water ("USDWs"). Although the presence or extent of any contamination remains unclear, some of these wells have been operating for decades, injecting billions of gallons of wastewater and other fluids into high quality drinking water.[6]

California's groundwater supplies are at a premium now more than ever. It is with this backdrop that any aquifer exemption application must be considered, and every effort made to protect this valuable resource.

DOGGR Needs To Explain Why These Disposal Wells Have Not Been Shut Down Already

In comparative analysis (Table 1) with the nine wells shut down statewide by the Division in March 2015, there's little, if any, difference between the depths, groundwater quality, and presence of surrounding water users. The disposal wells at Arroyo Grande are operating outside of the currently active hydrocarbon producing portions of the field; Figure 1 shows that currently active production and enhanced recovery injection wells are largely located within the 1973/1974 oil production boundary.

Further, the injection water quality characteristics are unknown. However, the injection water quantity is shown in Table 2, by year, for 11 out of the 14 non-compliant water disposal wells. Since the early 1980s, around the inception of the aquifer exemption program, roughly 63 million gallons of waste water have been injected into this protected aquifer.[7]

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[4] See "NASA Report: Drought Causing Valley Land to Sink", DWR press release, Aug19, 2015. Available here: http://www.water.ca.gov/news/newsreleases/2015/081915.pdf

[5] See "Progress Report: Subsidence in the Central Valley, California", Farr, T. G., Jones, C., Liu, Z., Jet Propulsion Laboratory, California Institute of Technology, August 2015.

[6] California Natural Resources Agency. Department of Conservation. *CALIF. DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES SEEKS END TO INJECTION IN KERN, TULARE COUNTY WELLS State's Review Is Ongoing; Look at High-Priority Wells Nearly Complete*. California Natural Resources Agency, 3 Mar. 2015. Web. 21 Sept. 2015. <http://www.conservation.ca.gov/index/news/Documents/2015-03%20Division%20of%20Oil,%20Gas,%20and%20Geothermal%20Resources%20orders%20UIC%20wells%20shut%20in.pdf>.

[77] See table 2: Underlying data for injection volumes were taken from DOGGR's well finder database (see an example well 0720498: http://opi.consrv.ca.gov/opi/opi.dll/WellFrame?UsrP_ID=100100100&PWT_ID=100015907&PWT_WellTypeCode=WD&StartRow=1&SortFields=WMtr_WellStatus&NewSortFields=WMtr_WellStatus&FormStack=WellList&PriorState=WMtr_APINumber%3D07920498&UsrP_RecentYearFirst=)

Note: upon review, information for well 0720419, while the magnitudes are accurate, are displayed in reverse order compared to the year.

Table 1: Comparison of relevant characteristics of the nine wells shut down in March 2015 and the disposal wells currently operating in non-exempt aquifers.

	Depth to Top of Inj Zone (ft)	Zone Water TDS (mg/L)	Injection Water TDS (mg/L)	Number of Supply Wells within 1 mile
Nine Injection Wells Shut Down 3/2015 °	475	710	13,000	None
	882	710	13,000	None
	490	680	618	5
	608	680	618	6
	1,400	444	460	40
	3,365	566	3,000	60
	1,415	366	1,500	None
	559	1,200	1,200	1
	250	916	1,500	1
	920	2,328	8,700	1
	1,493	539	No data	None
Proposed Arroyo Grande Aquifer Exemption 14 non-compliant active water disposal wells[+]	750*	1028[#]	No Data	47^

°http://www.biologicaldiversity.org/campaigns/california_fracking/pdfs/20140915_State_Board_UIC_well_list_Category_1a.pdf

* Based on the average Dollie Sand depth (application page 44)

[#] Equivalent concentration of 60 grain/gal (application page 44). Conversion was x17.118, according to http://www.water-research.net/Waterlibrary/watermanual/conversion_factors.pdf
However, it's unclear if groundwater samples were established outside of the hydrocarbon bearing zone.

^ On Page 278, the study area includes a boundary of 1 mile around the production area.
There were 105 wells located within that boundary, and 53 of those wells had a well completion report. Of those 53, 6 were completed in the Monterey Formation, which is not included in the proposed aquifer exemption proposal and subtracted from 53. Therefore, 47 wells with completion reports are located within 1 mile, in consistent geological zones with the aquifer exemption, of the proposed aquifer exemption boundary. The distance is approximate, because wells were reported at the quarter section level and further spatial resolution was not provided.

+ List of API numbers for 14 Non-compliant disposal wells within proposed exemption boundary:
7920419, 7920426, 7920433, 7920436, 7920498, 7920606, 7920639, 7920659, 7920773, 7920794, 7921105, 7921154, 7921202, 7921203

Table 2: API and Well Numbers of 11 of the 14 non-compliant water disposal wells within the proposed aquifer exemption boundary

	API and Well Numbers of Non-compliant UIC disposal Wells												
	7920419	7920426	7920433	7920436	7920498	7920773	7920794	7921105	7921154	7921202	7921203		
Year	135	140	142	161	169	2	3	4	6	7	8	Total Gallons Injected	Cumulative Gallons Injected
2015	514,735	0	1,234		7,890		258,686	185,782	76,790	61,094	4,956	1,111,167	63,160,377
2014	454,143	0	34,950		16,229		538,448	318,984	201,298	163,047	64,709	1,791,808	62,049,210
2013	281,477	39,375			17,203	486,876	695,534	438,420	195,781	12,604		2,167,270	60,257,402
2012	223,377	154,633			51,398	949,605	1,231,366	315,307	391,033	807		3,317,526	58,090,132
2011	194,300	179,601			40,002	877,230	1,284,340	477,412	205,105	27,153		3,285,143	54,772,606
2010	166,815	224,981			79,374	967,617	1,134,271	652,358	280,507			3,505,923	51,487,463
2009	261,008	33,806			126,418	1,581,441	850,156	337,671	108,721			3,299,221	47,981,540
2008	387,619	358,997			255,206	1,456,035	13,830	753,818				3,225,505	44,682,319
2007	443,890	334,076			241,215	1,610,248		774,915				3,404,344	41,456,814
2006	333,853	192,903			501,948	1,982,928		9,310				3,020,942	38,052,470
2005	357,363	226,238			215,055	1,424,775						2,223,431	35,031,528
2004	395,819	226,651			215,690	1,414,592						2,252,752	32,808,097
2003	352,901	133,601			476,070	1,484,729						2,447,301	30,555,345
2002	383,756	70,785			968,256	1,202,798						2,625,595	28,108,044
2001	466,972	84,782			51,146	2,014,869						2,617,769	25,482,449
2000	530,741	123,381			141,708	1,789,300						2,585,130	22,864,680
1999	575,091	145,584			240,924	1,922,778						2,884,377	20,279,550
1998	331,077	138,885			227,301	1,483,581						2,180,844	17,395,173
1997	338,166	91,290			184,202	526,226						1,139,884	15,214,329
1996	353,380	135,173			233,558							722,111	14,074,445
1995	357,134	118,997			256,782							732,913	13,352,334
1994	479,461	135,215			335,081							949,757	12,619,421
1993	311,775	13,148			676,991							1,001,914	11,669,664
1992	237,317				830,653							1,067,970	10,667,750
1991	175,643				585,313							760,956	9,599,780
1990	339,274				382,732							722,006	8,838,824
1989	356,318				331,555							687,873	8,116,818
1988	281,803				334,179							615,982	7,428,945
1987	241,921				361,030							602,951	6,812,963
1986	334,556				884,716							1,219,272	6,210,012
1985	162,584				1,300,035							1,462,619	4,990,740
1984				95,968	1,462,267							1,558,235	3,528,121
1983				752,318	962,214							1,714,532	1,969,886
1982				104,189	151,165							255,354	255,354

Alternative Disposal Methods Are Available

The applicant concludes with the threat that, "If injection of the waste waters from the WRF ["Water Reclamation Facility"] into the oil reservoir is not allowed, operations at the WRF will be shut down, subsequently eliminating the water supply that is currently benefiting the Southern California Steelhead and Tidewater Goby habitat." The suggestion that discharge of WRF water should be allowed to occur at the expense of possibly contaminating USDWs is wholly inappropriate and outside the regulatory scope of the proposed exemption application. If the injection of waste waters threatens USDWs, then it is absolutely appropriate that injection cease. This scenario presented by the applicant is also a false choice. None of the parties involved are proposing to completely prohibit subsurface disposal, merely requiring that it occur only into appropriate zones that are not non-exempt USDWs and will not contaminate non-exempt USDWs. The applicant's threat also implies that there are no means other than injection to dispose of reject water from the WRF, which is false.

Higher Bar Set by the State

California statutes set a higher bar than 40 CFR §146.4. Rather than being concerned exclusively with use of an aquifer as a drinking water source, Section 10350 of the Water Code defines "beneficial uses" as follows:

> "(f) "Beneficial uses" of the waters of the state that may be protected against quality degradation include, but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves."

Section 3131 of the Public Resources Code requires that the Division consult with the Water Boards prior to proposing an aquifer exemption to EPA concerning the conformity of the proposal with all of the following:

> *"(1) Criteria set forth in Section 146.4 of Title 40 of the Code of Federal Regulations.*
>
> *(2) The injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use.*
>
> *(3) The injected fluid will remain in the aquifer or portion of the aquifer that would be exempted."*[8]

The intent of the law here is not only to safeguard aquifers that currently serve as sources of drinking water, but for any "beneficial use", now or in the future, within reason. In addition, the law intends to ensure that fluids injected into an exempt (portion of) an aquifer will not migrate outside the exemption boundaries, i.e. that there is hydrologic isolation between exempt and non-exempt portions. This is a much broader remit, and one which cannot be justified merely on the basis of showing conformity with 40 CFR §146.4(a) and 40 CFR §146.4(b)(1).

As we explain in the following section, neither the Division and Water Boards nor Freeport-McMoRan have produced sufficient evidence that the portion of the aquifer proposed for exemption will not be of any beneficial use in the future. An analysis demonstrating the current and future technical or economic

[8] California Public Resources Code, Section 3131(a).

impossibility of beneficial use, based on levels of contamination, ease of access, technological availability of purification options and other factors is missing. In addition, we do not believe that the current data and proposed project operation practices demonstrate hydrologic isolation for the injectate.

Inconsistency with Goals of UIC Program

Granting this exemption may set a dangerous precedent, allowing operators of Class II wells to first potentially contaminate USDWs and then retroactively apply for exemptions for the very USDWs they may be contaminating. This may create a situation and an expectation whereby aquifers that previously would not have met the criteria for an exemption may in future qualify for one due to pollution caused by the operator.

TECHNICAL CONSIDERATIONS

Criterion 146.4(a) Has Not Been Met

In order to receive an exemption, the applicant must demonstrate that the proposed aquifer exemption meets the criteria at 40 CFR §146.4(a), which states that an aquifer can only be exempted if, "(a) It does not currently serve as a source of drinking water." The applicant has not adequately demonstrated that the proposed aquifer does not currently serve as a source of drinking water.

The applicant's well water analysis demonstrates that roughly 105 water supply wells are located within 1 mile of the aquifer exemption boundary (page 278). Of those, only 53 have well completion reports and known completion depths and spatial locations.

First, as a minimum requirement of satisfying 146.4(a), the application must identify the depths, status, and use of the remaining unidentified 52 wells.

While the current application suggests that private wells are not physically located within the proposed aquifer exemption boundary, the current application has not adequately identified groundwater flow directions, either local or regional, and how pumping activities within and around the aquifer exemption boundary impacts the hydraulic gradient. Information must be collected that demonstrates water level data, relevant geological features, and discharge rates for steady-state and non-steady state aquifer responses; to ultimately identify any potential *current* communication to the aquifer exemption boundary through a radius of influence induced by a discharge promoted cone of depression.

From a recent aquifer exemption in Texas, EPA denied a portion of a proposed aquifer exemption boundary due to "…significant lack of ground water elevation data for this area."[9] Furthermore, EPA stated "EPA cannot accurately determine whether the area would currently act as a source of drinking water because of the lack of data needed to determine the ground water flow direction north of the Northwest Fault." (*id*) Therefore, EPA rescinded a portion of the aquifer exemption that did not have sufficient ground water information to show that the aquifer was not currently being used.

The application relies heavily on anecdotal evidence and contains numerous vague and/or confusing statements indicating that the analysis of existing drinking water wells/uses is incomplete.

[9] http://www.epa.gov/region6/water/swp/groundwater/goliad-aquifer/transmittallettertotceq.pdf

To justify that the aquifer in question is not a current source of drinking water and is not hydraulically connected to the current users, the applicant states "There is no evidence that the injected fluids have migrated beyond the confines of the reservoir after decades of injection operations. Cleath Harris Geologists ("CHG") was retained by the applicant to conduct a review of the groundwater supply well logs within a mile of the oilfield (App. G (1-1)). CHG's report validates that *most* of these water wells in the region are in separate structural sub-basins, hydraulically isolated from the oil field" (emphasis added). (p 8-9) This statement implies that not all of these water supply wells are hydraulically isolated from the oil field.

The applicant goes on to state, "None of the logs contained information, notes, or entries indicating heat from the oil field thermal operations had been encountered when the groundwater supply wells were drilled." (p. 9) However, neither the applicant nor its consultant provided the dates when the water wells were drilled or dates when steam enhanced oil recovery ("EOR") operations commenced. If the groundwater supply wells were drilled prior to the commencement of EOR activities, then of course heat from oil field thermal operations certainly would not detected. Additionally, it is unclear why heat alone was the only factor considered when determining whether or not oil field thermal operations may have impacted nearby groundwater resources, when these operations may also have impacted water chemistry. They then state, "Furthermore, the logs of the groundwater supply wells did not provide any evidence of hydrocarbon saturation *on the same level* as evidenced by the logs of wells drilled within the confines of the oil reservoir" (emphasis added) (p. 9). The phrase "on the same level" is vague and implies that hydrocarbons are present in these groundwater supply wells, indicating that they are not hydraulically isolated from the oil field.

The applicant states, "Well 'Rock' 85 is adjacent to Phase IV Sentry monitoring well MW-2 which has not shown any events related to oilfield operations since it was installed nine years ago." (p. 14) It is not clear what is meant by "events" or how the lack such events demonstrate that injection operations do not endanger groundwater. In a similar statement, the applicant claims, "No incidents or observed detrimental effects to the localized environment or groundwater resources have been documented since injection operations into the Dollie zone were initiated, thus providing anecdotal support to the observations that the reservoir is geologically confined." (p. 17) Again, the meaning of "detrimental effects" is not defined and is not clear whether the operator has actually been monitoring for such effects.

The applicant and its consultant have not definitively determined that the various subbasins are indeed isolated from the proposed exemption zone, stating, "The Indian Knob Valley subbasin *appears* structurally and hydraulically isolated from other water-bearing zones in the study area," and "The Oak Park subbasin, which covers areas mapped as Edna and Squire Members of the Pismo Formation, *appears* structurally and hydraulically isolated from other water-bearing zones in the study area" (emphasis added) (p. 20). This is an unacceptable condition for adequate protection of USDWs.

The proposed aquifer exemption application presents insufficient information on the potential for private well users that could be currently drawing water from within the proposed aquifer exemption boundary. Based on the available information, EPA cannot grant this exemption based on 146.4(a).

Criterion 146.4(b)(1) Has Not Been Met

The applicant claims that the proposed aquifer exemption is justified based on the criterion at 40 CFR §146.4(b)(1), which states that an aquifer can be exempted if:

> *"(b) It cannot now and will not in the future serve as a source of drinking water because:*
>
> *(1) It is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible."*

The applicant has not adequately demonstrated that this criterion has been met.

Presence of Hydrocarbons in Commercial Quantities Has Not Been Adequately Demonstrated

The applicant proposes to exempt the Edna/Dollie Sands Member of the Pismo Formation from ground surface to the base Edna/top Miguelito Member on the basis that "There are only hydrocarbon-bearing sands in the oilfield." The applicant states that this claim is supported by sidewall and whole core data, production data, and well logs.

40 CFR §146.4(b)(1) requires an aquifer to be hydrocarbon producing, or contain hydrocarbons in quantities that are "commercially producible." In other words, it is not sufficient to simply demonstrate that hydrocarbons are present in the proposed exemption zone; the applicant must also demonstrate that those hydrocarbons are, or can be commercially producible, due to their size and location. The applicant has failed to demonstrate this throughout the entire proposed exemption volume.

DOGGR and EPA have already exempted the hydrocarbon bearing zone, within the aquifer exemption boundary, as demonstrated in Figure 1. According to the 'List of Permitted Wells Sent to EPA'[10] spreadsheet, 14 disposal wells (green dots) and 76 EOR wells (pink dots), all of them non-compliant, are located within the proposed aquifer exemption ("AE") boundary (red line), yet outside of the currently exempted, hydrocarbon bearing aquifer boundary (blue line). The hydrocarbon bearing unit was based on a shapefile provided through DOGGR's FTP website, which delineated the spatial boundaries for the 1973 and 1974 oil productive units. However none of the active UIC wells located within the exempted, hydrocarbon bearing aquifer were listed in the 'List of Permitted Wells Sent to EPA' spreadsheet suggesting they are in-compliance with SDWA.

[10] http://www.conservation.ca.gov/dog/general_information/Pages/UndergroundinjectionControl(UIC).aspx

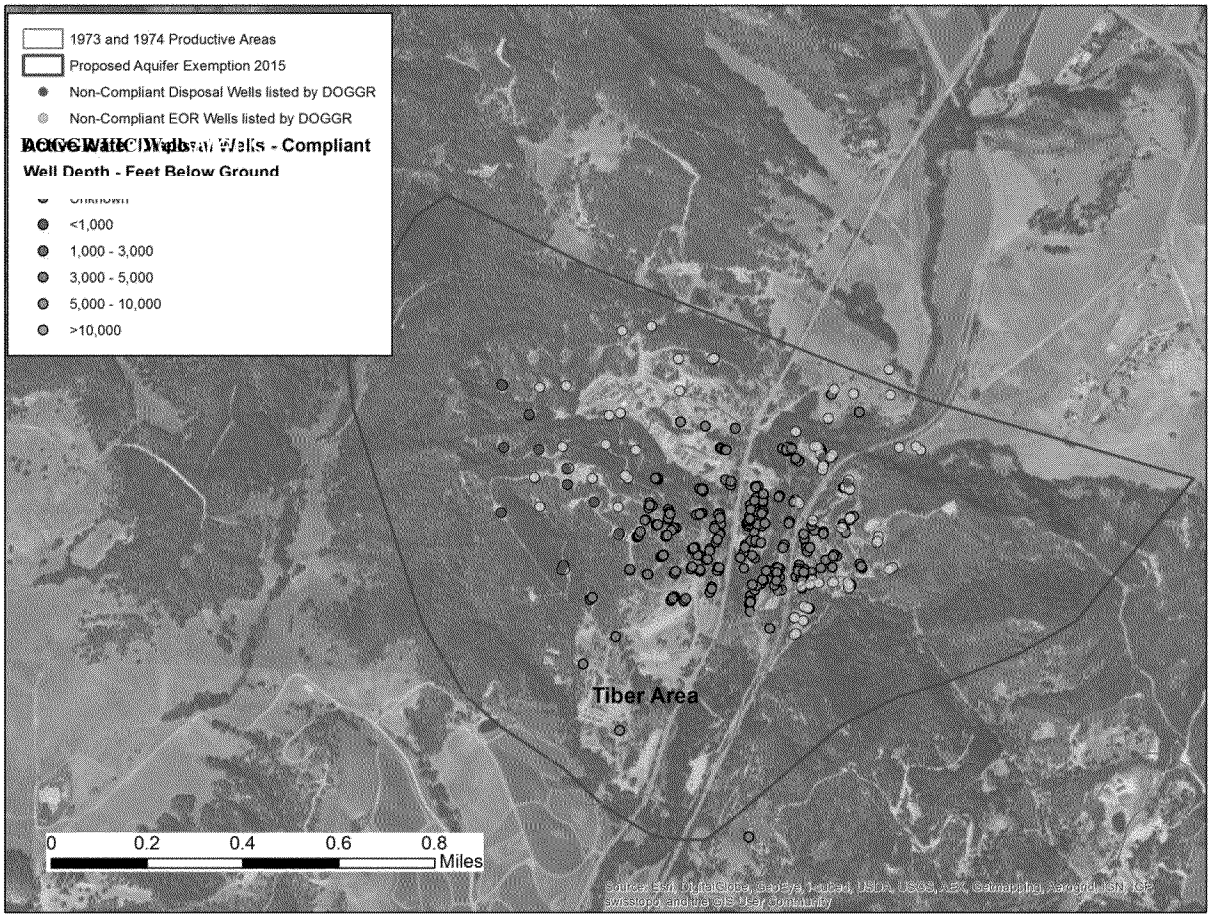

Figure 1: Site map showing the proposed aquifer exemption boundary (red line), the current aquifer exemption boundary (blue line), the non-compliant UIC wells, and compliant disposal and EOR wells.

EPA must not grant an aquifer exemption for disposal wells based on 40 CFR §146.4(b)(1), for a non-producing portion of the aquifer that is also not demonstrated to be suitable for economical hydrocarbon recovery. While the applicant claims, "Hydrocarbons are distributed throughout the oilfield reservoir, both vertically and aerially" (page 3) the location, distribution, and recovery of the economically producible hydrocarbons are overwhelming located within the already exempted portion (blue line) of the proposed aquifer exemption (red line). Currently, the zone outside the boundary of the existing exemption is host mostly to disposal wells.

Core Data Deficiencies

A significant amount of sidewall and whole core data is available for the field. However, the depth to the shallowest core sample is 122 feet.[11] The average shallowest core sample depth is 462 feet. Consequently, much of the shallow subsurface of the oil field within the proposed aquifer boundary is not characterized with core data.

[11] The applicant does not specify the datum for the core depth data. We assume that the datum is the ground surface and that depths are MD.

The applicant also has not provided the dates on which these core samples were taken nor the methodology used to determine oil and water saturation, making it difficult to accurately interpret this data. Oil saturation is typically determined indirectly based on water saturation. Accurately determining oil saturation requires knowing whether cored intervals contain only moveable hydrocarbons, or both moveable hydrocarbons and moveable water. The latter situation can occur in oil fields with long development histories, such as Arroyo Grande, and requires more sophisticated analysis to determine saturation. Additionally, samples taken years or decades ago likely no longer represent the current saturation state of the cored intervals, particularly those in which enhanced recovery operations have occurred. As presented, the core data is insufficient to establish the presence of commercially producible hydrocarbons throughout the entire proposed exemption volume.

Well Log Data Deficiencies

The applicant claims that resistivity logs demonstrate the presence of oil saturated sands throughout the entire proposed exemption volume, both vertically and aerially. The applicant appears to claim that resistivity readings greater than a cutoff value indicate the presence of hydrocarbons, which is represented as green shading on resistivity logs. However, neither the value(s) of this cutoff nor the justification for using such cutoff has been provided in the application.

Distinguishing hydrocarbon-bearing zones from water-bearing zones requires running resistivity logs that interrogate at multiple depths into the formation in order to determine the resistivity profiles for the flushed, invaded, and uninvaded zones of the borehole, and by extension determine the resistivity values for formation water and hydrocarbons. In the cross-section presented in Appendix A7a7, only a single resistivity log is presented for each well, despite the fact that in some cases the log header indicates that shallow, medium, and/or deep resistivity measurements were taken. Additionally, although log headers for core data appear in tracks two and three, these values are not plotted on the logs. Comparison of core- and log-derived data is an important check on saturation values.

Distinguishing water- from hydrocarbon-bearing zones is further complicated in the Arroyo Grande field by the fact that the formation water is low TDS, meaning that both formation water and hydrocarbons will have high resistivity. In fact, the applicant's own data appears to demonstrate that the resistivity cutoff may not be valid. In Appendix A7a3, cross section C-C', a note next to the Guidetti A-1 well log states, "Mudlog shows Edna Member (Dollie sand) gray, wet (no shows) sands from 90' to 1600' MD." Yet, the resistivity log from approximately 600' to 1200' MD is shaded green, which the applicant claims indicates the presence of hydrocarbons.

The applicant has not justified how a resistivity cutoff value can be used to distinguish water-bearing zones from hydrocarbon-bearing zones. Given that the applicant's claim that hydrocarbons are ubiquitously present throughout the field is heavily reliant on its assertion that resistivity logs demonstrate the presence of hydrocarbon-bearing zones, this is a significant shortcoming of the application. As presented, the log data is insufficient to establish the presence of commercially producible hydrocarbons throughout the entire proposed exemption volume.

Completions Data Deficiencies

The applicant states that pre-1974 completion data, "…demonstrate oil production at all levels of the reservoir that are being developed currently." However, Appendix A7a7, AG Pre-1974 Well Completions

Cross Section, indicates that wells are typically completed approximately between the top M1/M2 Marker and tar seal/top M12 Marker of the Edna/Dollie Sands Member. This is also confirmed by well files for a sample of recently completed wells, which show that the top perforation or top slot for wells completed with a slotted liner coincides approximately with the top M1/M2 Marker, and the lowest perforation or bottom slot coincides approximately with the top of the M12 Marker:

API	Top Perf/ Slotted Liner	Bottom Perf/ Slotted Liner	Top M2 (feet MD)	Top M6 (feet MD)	Top M12 (feet MD)
07921222	280	1454	490	611	1262
07921217	419	1573	579	797	1377
07921203	460	820	451	662	-
07921174	641	986	192	293	1023
07921171	744	1619	724	921	1583
07921170	746	1636	728	944	1609
07921162	270	1150	228	346	1178
07921161	251	1195	-	324	1057
07921160	280	1012	214	330	1014
07921158	403	1547	574	721	1396
07921157	412	1530	580	717	1346
07921154	603	1055	631	1015	-
07921140	270	1197	378	503	1175

Additionally, the applicant states that, "…fluid injection is a minimum of 450' from surface," confirming that production and injection do not take place in the shallow subsurface. Despite this, the applicant is proposing to exempt the entire Edna/Dollie Sand Member from surface to the top of the Miguelito Member.

The applicant has not demonstrated that commercial production is occurring or possible, as required by 40 CFR §146.4(b)(1), either shallower than approximately the top M1/M2 Marker or deeper than the tar seal/top M12 Marker. As such, these intervals are not eligible for an aquifer exemption. Including the portion of the Edna/Dollie member from the tar seal/top M12 Marker to the top Miguelito in the exemption significantly increases the total exempted volume, particularly in the updip portions of the field to the north and west where the productive horizons thin and shallow, as demonstrated in x-sections B-B', C-C', and D-D'. Additionally, exempting this portion of the Edna/Dollie member is inconsistent with the applicant's claim that the tar seal is in fact a basal confining zone capable of preventing the movement of fluids.

The proposed aquifer exemption boundary must either be revised, the applicant must provide additional information to demonstrate that 40 CFR §146.4(b)(1) is met for the entire proposed exemption volume, or the applicant must rely on a different criterion to justify the exemption.

Analysis of Alternatives to 40 CFR §146.4(b)(1)

The applicant has not adequately demonstrated that the requirements under 40 CFR §146.4(b)(1) are met for the entire proposed aquifer exemption volume. Therefore, for the EPA to consider this aquifer exemption so that it complies with 146.4(b), the applicant must demonstrate one of the other 146.4(b) criteria has been adequately satisfied.

Exemption Under 40 CFR §146.4(b)(2) Is Inappropriate

40 CFR §146.4(b)(2) requires that: "*It is situated at a depth or location which makes recovery of water for drinking water purposes economically or technically impractical.*"

Since the proposed exemption is from the ground surface through the Edna member of the Pismo formation, this option is inappropriate. The depth to the bottom of the formation varies, but generally is <1,000 feet deep. This is more than economically feasible and practical for drinking water purposes, now and in the future. According to the applicant's private well analysis of DWR data (page 278), there are ~53 private supply wells (with well completion reports, 105 total private supply wells) within 1 mile that are drawing water from aquifers generally <1,000 feet deep.

Exemption Under 40 CFR §146.4(b)(3) Would Require Additional Supporting Data; Application Under Such Is Inappropriate Under State Law

40 CFR §146.4(b)(3) requires that: "*It is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption.*"

Water quality data presented in the application (page 251)[12], was sampled from wells within the currently exempted, hydrocarbon bearing aquifer. This aquifer represents an already exempted, hydrocarbon bearing aquifer and data from this aquifer does not represent geochemical conditions and groundwater quality outside the hydrocarbon bearing zone.

For this condition to be adequately satisfied, the applicant would need to demonstrate a statistically sound number of random groundwater samples *outside* of the hydrocarbon bearing portion of the aquifer to adequately characterize the groundwater. For characterizing the water quality, EPA's unified guidance on establishing groundwater monitoring programs should be used.[13]

According to the information provided in table 2, roughly 63 million gallons of waste water have already been injected into this aquifer. From the data available currently, it's largely unclear what impacts have transpired on groundwater quality. However, the applicant is treating 21,000 bwpd of produced water at the WRF, three quarters of which is discharged into Pismo Creek. This demonstrates that it is already economically and technologically practical to render this water fit for beneficial uses.

Based on the sampling results and analysis, justification for 146.4(b)(3) could be either be supported or denied based upon the presence of water contamination making these portions of the aquifer unfit for

[12] Of note: We were unable to locate the API numbers in the application or in DOGGR's spreadsheet containing all UIC wells, for several of the well listed. Nor were dates, QA/QC reports, or sampling data available for review.
[13] http://www.epa.gov/wastes/hazard/correctiveaction/resources/guidance/sitechar/gwstats/unified-guid.pdf

human consumption. However, adequate supporting analysis to that effect has not been presented, and indications are that such a demonstration would be unlikely.

Exemption under 40 CFR §146.4(b)(4) Is Not Applicable

40 CFR §146.4(b)(3) requires that: *"It is located over a Class III well mining area subject to subsidence or catastrophic collapse."*

This exemption application is not associated with a Class III well mining area, and this option is irrelevant.

Additionally, as we outline above, the Division and Water Boards under the California Public Resources Code are tasked with ensuring that "the injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use" before submitting an aquifer exemption application to EPA. Regardless of the requirements under 40 CFR §146.4(b), given the shallow depth of the field and the already existing beneficial use (industrial), it appears that submission of this application to EPA is inappropriate.

Comments on the Applicant's Hydraulic Analysis

EPA does not need an applicant to demonstrate hydraulic confinement to grant an aquifer exemption. This alarming fact demonstrates a severe flaw in this regulatory program and demonstrates how little analysis is required for this scientifically invalid regulatory process. However, as demonstrated above, the proposed aquifer exemption has not met EPA's requirements for criteria 40 CFR §146(a) and 40 CFR §146.4(b). Therefore, EPA must not approve this aquifer exemption application in its current form. Furthermore, as discussed above, the State of California sets a higher bar, requiring that the applicant demonstrate that injected fluid will remain in the aquifer or portion of the aquifer that would be exempted. This standard has not been met, as discussed in detail below, and the Division and Water Boards should not submit this application to EPA in its current form.

'Tar Seal' and Adequate Confinement

The applicant needs to explicitly define 'tar seal'. We were unable to locate a definition or explanation of the term, nor its consistent or widespread use, through a relevant peer-review literature search, in relevant scientific textbooks[14], or even through a general online search. Further, what protocol was used to delineate the boundaries of the 'tar seal' needs definition and clarification. First and foremost, the applicant needs to define the intrinsic properties as a seal that would preclude the transmission of contaminants or potentially impaired groundwater outside the boundary of the proposed exemption. The blanket assumption that this 'tar seal' will act as an impermeable, barrier indefinitely is grossly underestimating the potential for off-site migration of contaminants into USDWs and potential drinking water sources.

Furthermore, the injection of steam is a cause for concern, since steam could (further) impair the integrity of the seal. For example, the well-established extraction technique known as Steam Assisted Gravity Drainage used for hydrocarbon production from tar sands relies on injecting steam to melt the bitumen

[14] Bates RL, Jackson JA. Dictionary of Geological Terms. 3rd ed. New York: The American Geological Institute; 1984.

and allow it to flow to a nearby well. The technique is used extensively in Canada.[15] Given this ability of steam, we call into question the assertions of confinement put forward by the operator.

Confinement on east and west side of the proposed exemption boundary has not been established. On page 16, the applicant notes, *"The reservoir thins and pinches out (facies change) up-dip into the less permeable, finer-grained Edna Member sands and to the very fine-grained Miguelito Member siltstones and claystones. The reduction in permeability to finer-grained sands, siltstones and claystones provides the seal preventing fluid or steam migration eastward or westward from the oilfield."*

This statement is troubling for several reasons. First, according to Hall 1973, the Miguelito member is inconsistently distributed throughout the proposed spatial area. Hall 1973 definition[16] suggests discontinuities in the Miguelito member which could significantly alter preferential flow paths and hydrogeological characteristics throughout this aquifer.

Next, according to throughout DWR's (application page 278) private well report, 6 well completion reports are located within 1 mile of the proposed aquifer exemption and are located in the Miguelito Member. The presence of private wells currently drawing from this aquifer suggests 1) it is capable of storing and transmitting significant amounts of groundwater, 2) it is an aquifer, not a confining aquitard or aquitude, and 3) depending on various hydrogeological factors, there's a potential of well discharge to enhance the hydraulic gradient away from the aquifer exemption boundary.

Additionally, as shown in maps and cross-sections provided by the applicant, permeable Edna Member sands extend to the east-southeast and west-northwest of the proposed exemption boundary (Appendix A 4-1 and Appendix A7a2). The applicant has not adequately demonstrated that there are any geologic features at the proposed boundary that could prevent injected or displaced fluids from migrating beyond the proposed boundary into these permeable Edna Member sands. The applicant has not provided any permeability or porosity maps or cross-sections documenting the alleged loss in permeability it claims will provide confinement on the east and west sides of the field. The applicant has not presented any density porosity or neutron porosity logs and, as discussed above, although core permeability and porosity data are available, these have not been plotted on the cross-sections submitted by the applicant.

Finally, for the current 'hydraulic analysis' to be appropriate for this site, the applicant needs to demonstrate 1) site specific information of confined aquifer conditions, 2) adequate characterization of the boundary conditions and not assumptions, and 3) quantitative aquifer properties and understanding of head level responses.

It's unclear whether or not the proposed aquifer is under confined or unconfined conditions, which has significant implications on predicting how phreatic (or potentiometric) surface will be influenced by various injection and recovery activities. Artificial changes to the hydraulic gradient must be assessed in

[15] See, for example, http://www.conocophillips.ca/technology-and-innovation/unconventional/Pages/sagd.aspx and http://www.energy.alberta.ca/OilSands/pdfs/FS_SAGD.pdf

[16] defined as *"Interbedded brown siltstone and claystone, moderately resistant, bedded (beds average 4 in. thick). Locally, claystone hackly fractured with lenses of siliceous or dolomitic siltstone. Opaline and porcelaneous shale in the west. Locally bituminous sandy siltstone. Tmpm2 – Brown silty claystone and siltstone, poorly bedded."*

order to understand local groundwater flow conditions, along with a quantitative description of the structural aquifer characteristics.

Presence of Surface Tar Seal Not Adequately Demonstrated

As part of its justification for exempting the Edna/Dollie Sands Member from surface to depth, the applicant claims that a "tar seal" is present across the entire surface of the proposed exemption boundary. To support this claim, the applicant references maps and cross-sections prepared by DOGGR in 1944 and 1958 showing the location and distribution of tar sands. Neither of these maps is consistent with the applicant's interpretation that the "tar seal" is present across the entire surface of the proposed exemption. Both publications from DOGGR show that the tar sands occur in discrete and discontinuous deposits that outcrop at various locations throughout the field, contradicting the applicant's stylized cross-sections in Appendices A7a1 – A7a6, which depict the "tar seal" as a single, continuous deposit at the surface.

Conclusion

The current draft application has not demonstrated compliance with existing Federal requirements for approving new aquifer exemptions. The analysis presented does not demonstrate the absence of drinking water wells within the proposed exemption area, and the operator has failed to demonstrate that hydrocarbon production is taking place, or can commercially occur in the future, from the entire extent of the proposed exemption. In addition, the Division and Water Boards should not submit the application to EPA in its current form, as it fails to demonstrate hydraulic confinement with any reasonable degree of confidence, and beneficial use from portions of the aquifer that would be exempted is already taking place and is very plausible, or even likely, in the future. While the additional conditions DOGGR and the Water Board are considering incorporating into any future project approvals and permits, such as monitoring wells and a "buffer zone," are entirely appropriate, it is not at all clear how and under what authority either agency would implement these in practice, nor can the approval of an aquifer exemption by EPA, to our knowledge, be based on the conditional implementation of project-level measures under state authority by other agencies. Therefore these proposed measures provide little additional assurance that injected fluid will remain in the proposed exempted area. In fact, they point towards uncertainty and lack of confidence in confinement.[17]

Significant new evidence and analysis would need to be presented in order for the currently proposed boundary to be eligible for submission and approval for exemption – if this is indeed possible. At the very least, the lateral extent as well as the vertical extent of the proposed boundary would need to be revised in order to qualify as hydrocarbon bearing or commercially producible zones, and to satisfy hydraulic confinement requirements.

[17] California State Water Resources Control Board. (n.d.) Preliminary Concurrence on the Dollie Sands of the Pismo Formation Aquifer Exemption Document, Arroyo Grande Oilfield. [Memorandum] Sacramento, CA.